Exhaust Emissions Controls for Diesel Locomotives – Experience in Europe

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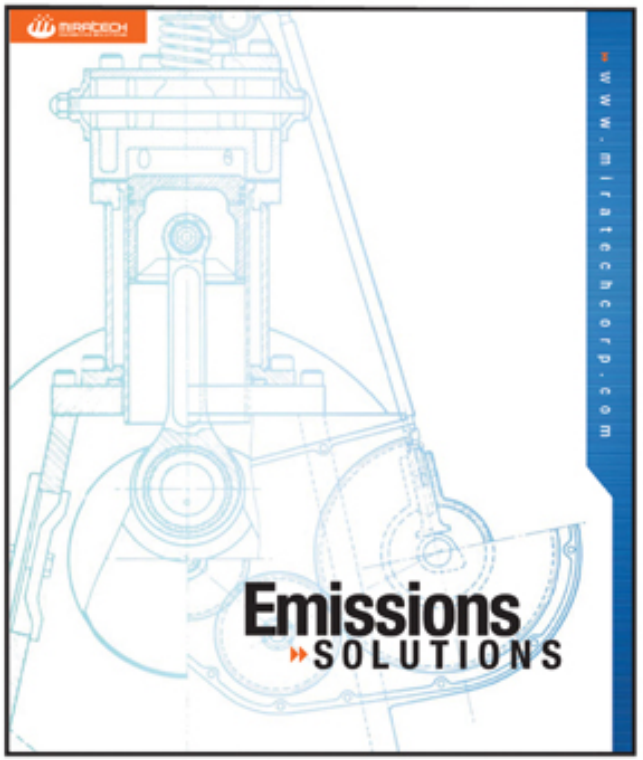
Overview

- **MIRATECH Background**
- **Diesel Emissions Control Technology Background**
- **MobiClean™ Diesel Particulate Filter**
- **Locomotive Applications in Europe**



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Who is MIRATECH?

- **Privately held company located in Tulsa, Oklahoma**
- **Design, sell, and service emissions control equipment for industrial reciprocating engines**
  - **Both diesel and natural gas engines**
  - **Reliability and durability very important**
- **North American sales coverage**
  - **Regional sales managers and network of distributors and representatives**
- **Access to state of the art technology through partnerships**
  - **HUG Engineering: SCR and Soot Filters**
  - **EcoCat: Three-Way and Diesel Oxidation Catalyst**

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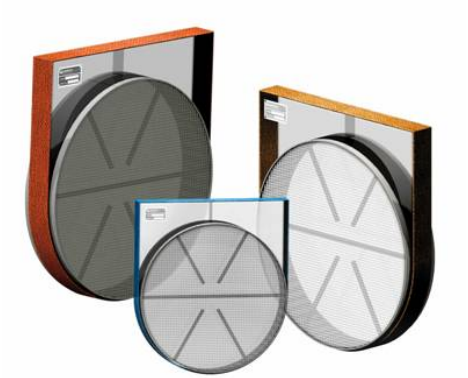
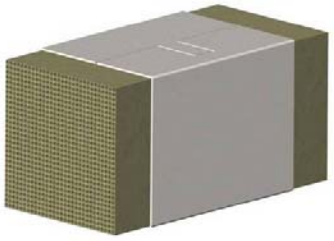
Diesel Emissions Reduction Technology

- **Diesel Oxidation Catalyst (DOC)**
  - + 20 to 40% PM Reduction
  - + 90% CO and VOC Reduction
  - – Oxidizes Some NO to NO_2
  - – Can Form Sulfates from Sulfur in Fuel
  - ▪ > 400 F
- **Selective Catalytic Reduction (SCR)**
  - + 90% NOx Reduction (Steady Load)
  - + 10 to 30% PM Reduction
  - – Requires Urea or Ammonia Storage and Injection System
  - ▪ 600 – 900 F
- **Diesel Particulate Filters (DPF)**
  - + 90% PM Reduction
  - – Requires Active Regeneration System for Low Temperature Applications
  - – Increased Backpressure
  - ▪ > 700 – 850 F

Metal Foil Elements



Extruded SCR and Filter Blocks



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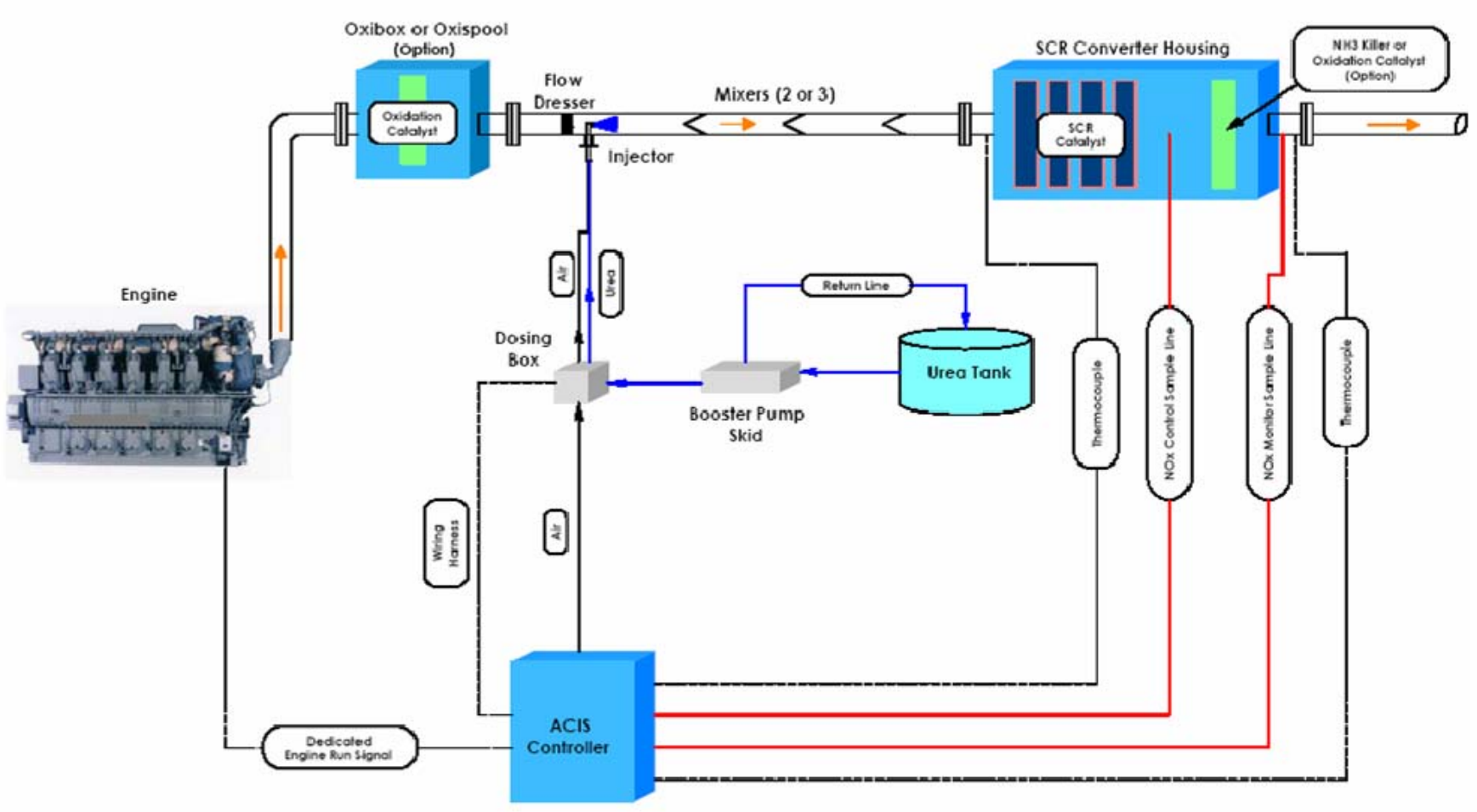
Stationary Engine SCR System



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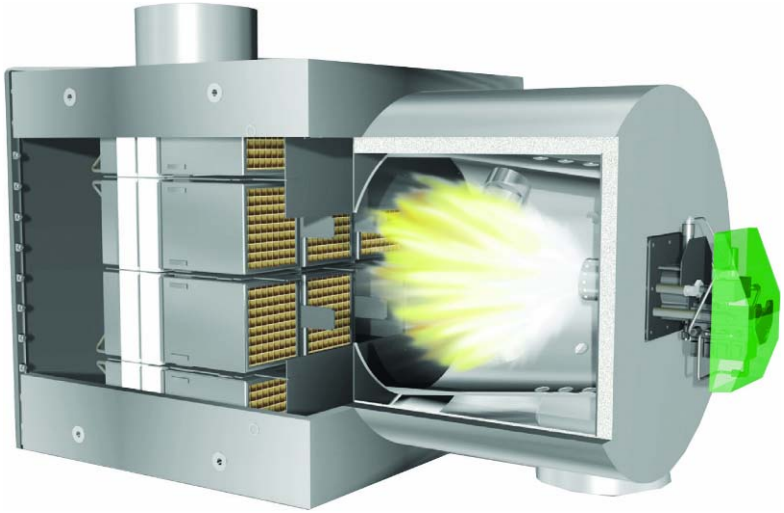
MobiClean™ Particulate Filter

Exhaust Soot Filter System for Mobile Diesel Applications

Regeneration without Increasing NO_2!



- Modular System Various Engine Sizes
- Silicon Carbide Filter Elements
- Active Regeneration Burner for Low Exhaust Temperatures
- Excellent Sound Absorption (Replaces Silencer)
- Compact Design for Tight Spaces
- Rugged Design for Demanding Applications:
  - Locomotives
  - Railway Construction Machines
  - Mobile Power Plants
  - Ferries and Yaughts
  - Mining Equipment

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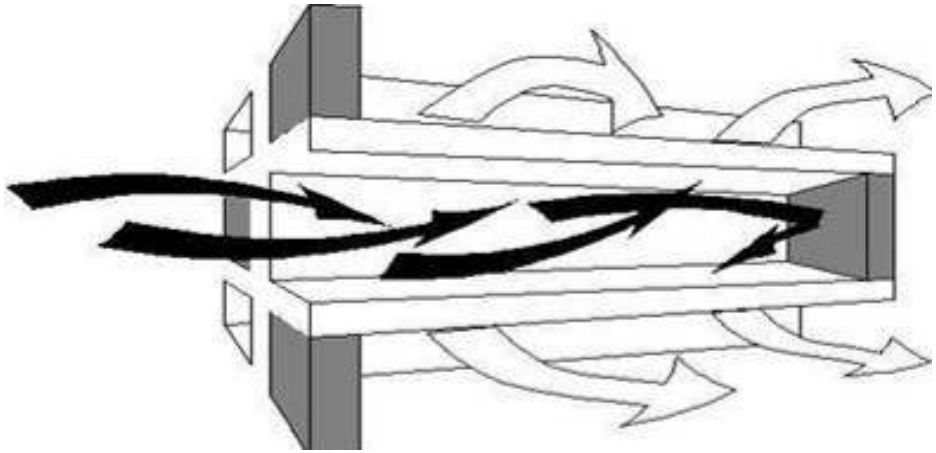
MobiClean™ Filters

Silicon Carbide Filters

- **Particulate is trapped on the surface of a catalyzed, high temperature, wall flow, porous Silicon Carbide filter**
- **Silicon Carbide provides superior thermal durability over metal fiber and cordierite filters**
- **Sulfur Tolerant Catalyst Applied to Reduce Regeneration Temperature**
- **Level 3 CARB Verification for Stationary Diesel Generators**



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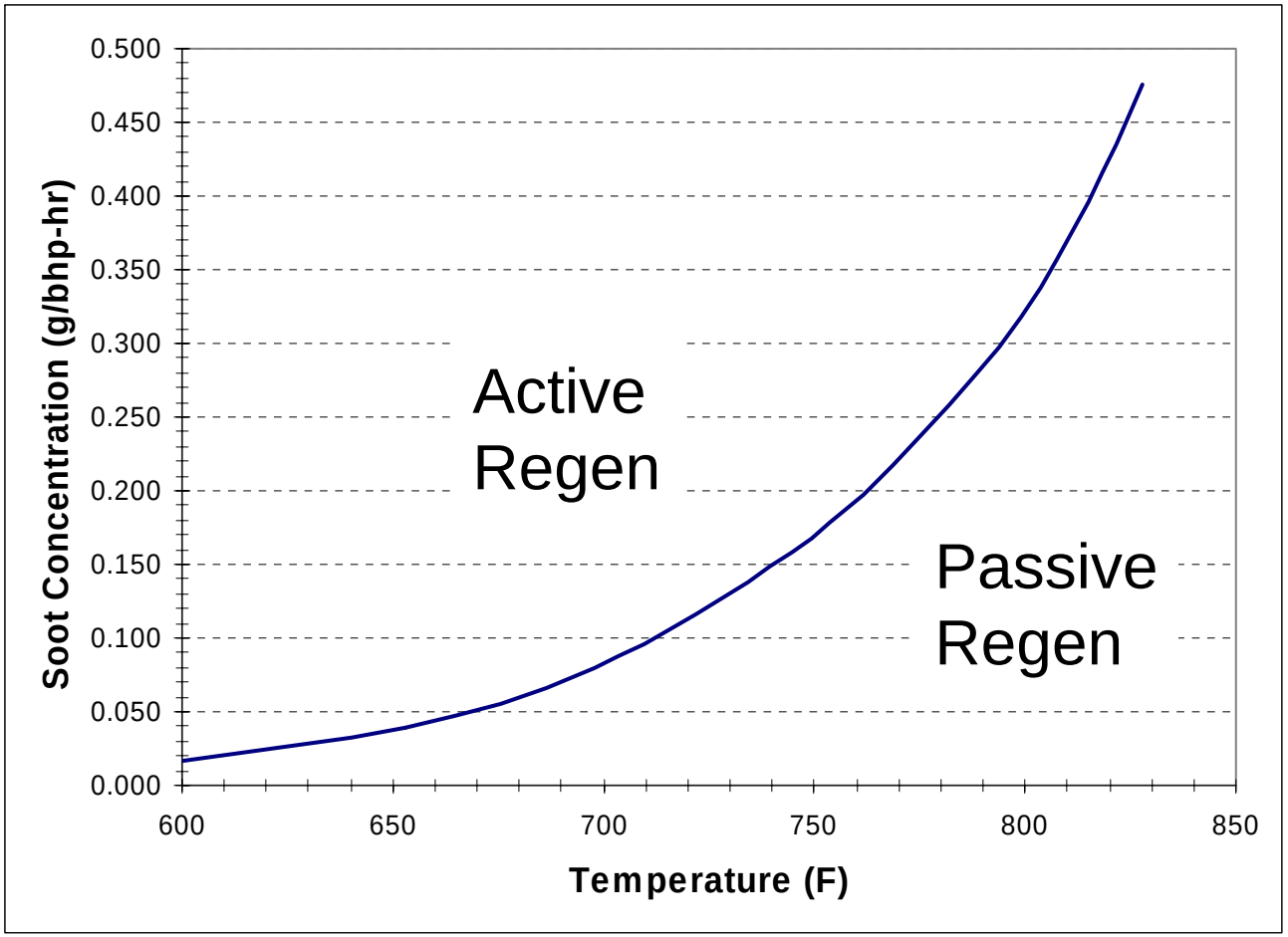
Soot Burning vs. Temp



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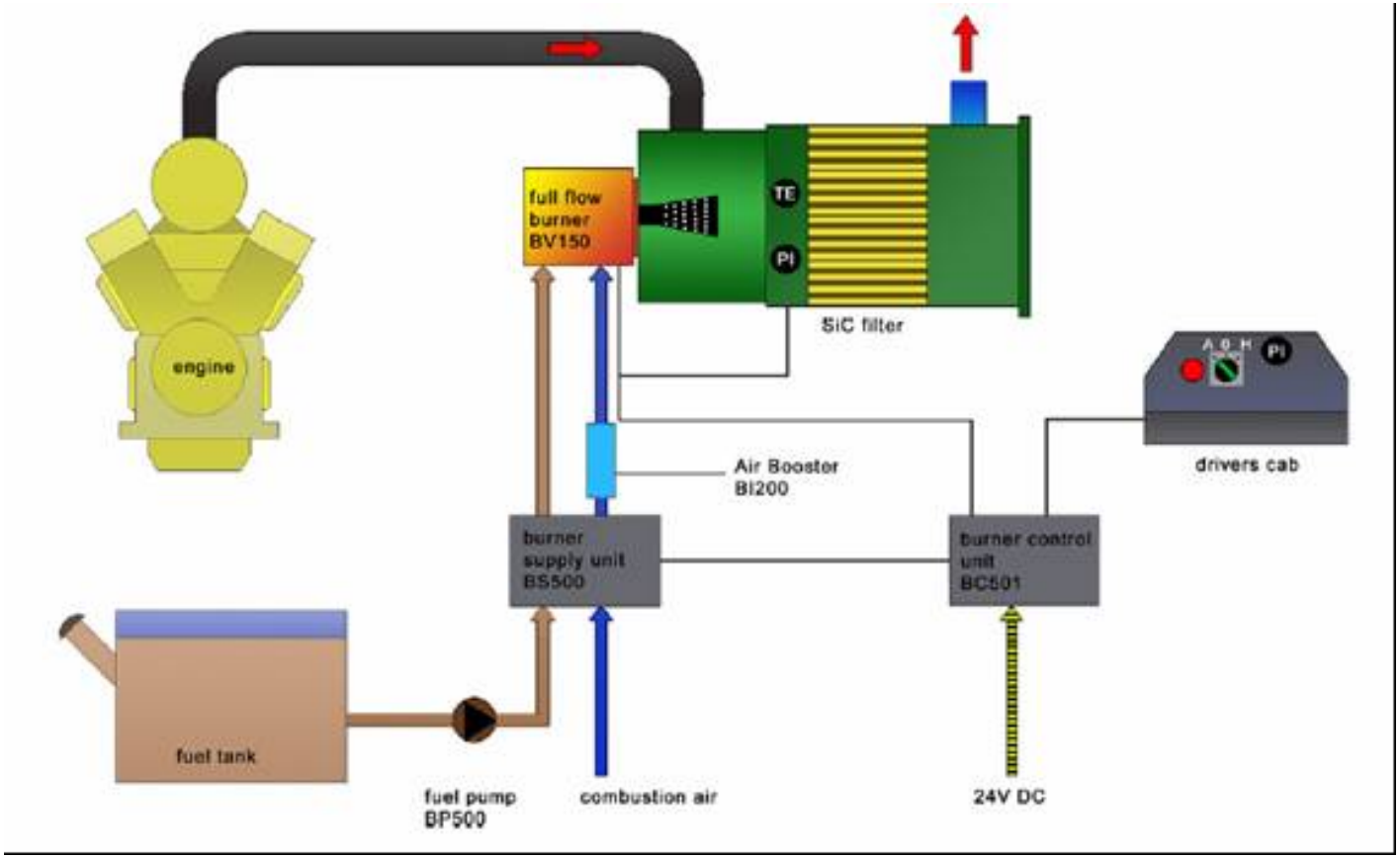
MobiClean System Layout



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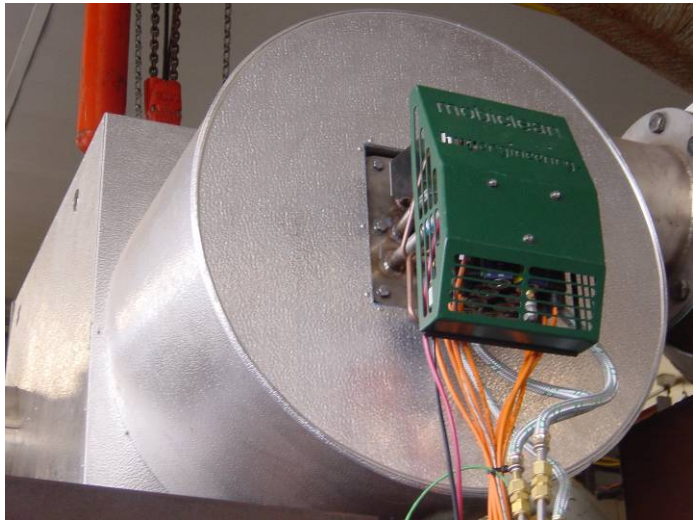
MobiClean™ Features

- **Individually Encased Filters that Bolt in Place**
- **Filters Can Be Removed for Cleaning/Replacement**
- **Lifting Handle for Carrying Filters**
- **Side or Top Access, Depending on Design**
- **Burner System Mounts on Front or Side**
- **Rugged PLC Controller for Burner System Mounted Remotely from the Filter Housing**



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MobiClean™ Locomotive Experience

- **First Installed on Railway Maintenance Vehicles in Switzerland in 1997**
- **Applied on ~76 New SBB Am843 Locomotives (S26)**
- **Applied on Several Hundred Railway Maintenance Vehicles**
  - **Both Retrofit and New Applications**
- **Custom Designs to Fit Space Requirements**
- **Filters Can be Mounted Vertically or Horizontally**

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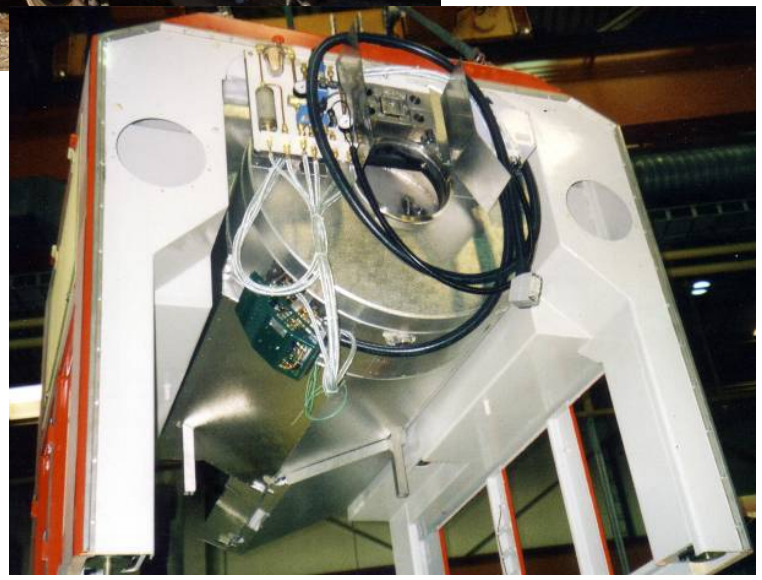
SBB: Am843 - 2000 HP Switcher



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Vossloh 3500 HP Locomotive

- **MTU 20V4000, High Speed, 4-Stroke Engine**
- **MobiClean S56 with Dual-Burner System**
- **Installed on One Demonstration Locomotive**

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R 21 U (204 kW) Rail Track Machine

MobiClean™ S4

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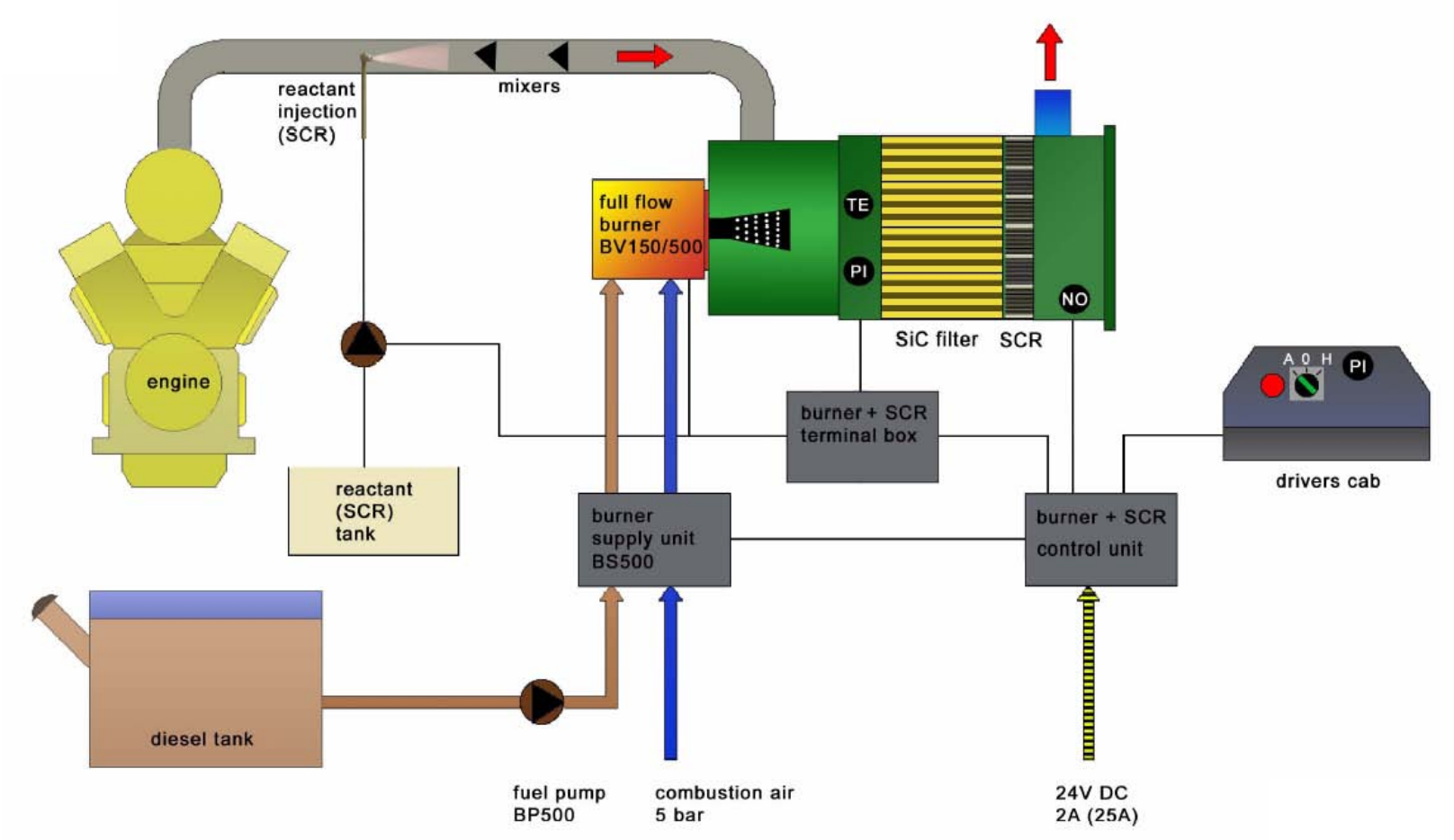
Combined SCR/DPF System



Currently Being Tested on a Railway Maintenance Vehicle

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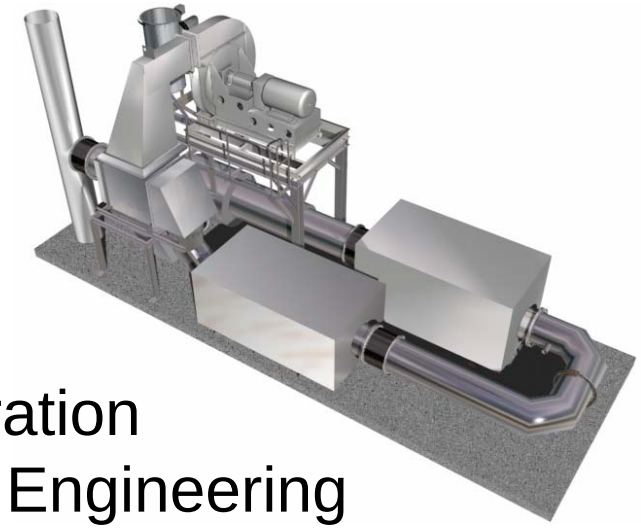
SNCF Train Station Paris

Stationary
Locomotive
Exhaust Clean
Up System



4 Units, All with Same Stack Configuration
SCR and PM Filter Supplied by HUG Engineering

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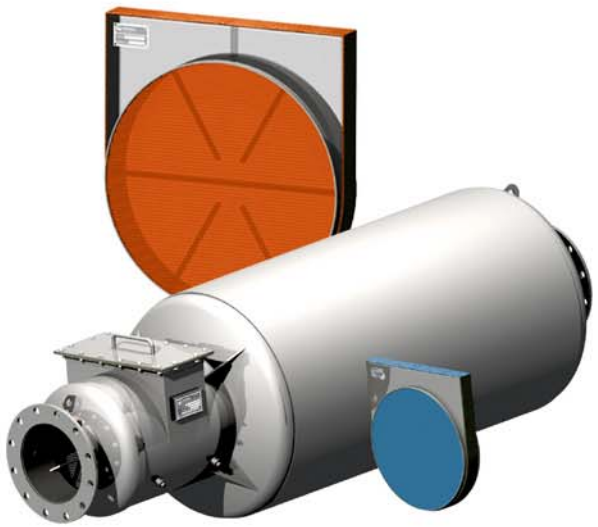

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